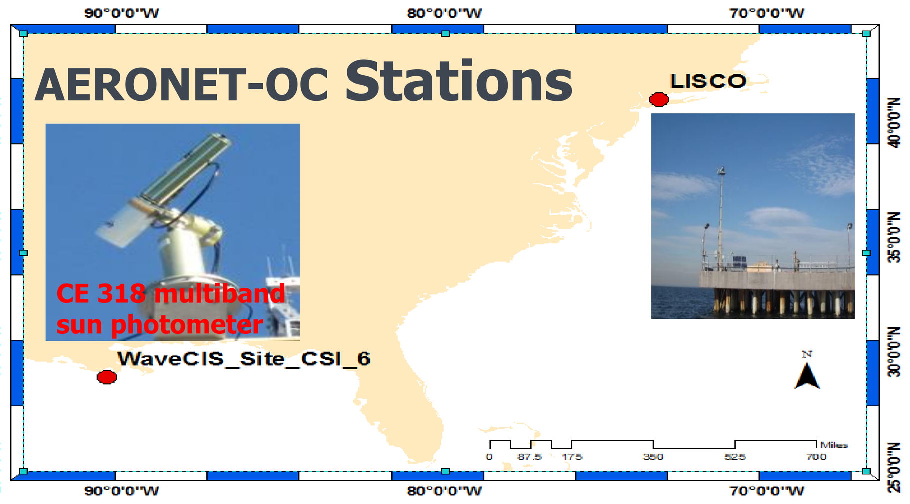
Comparison of aerosol characteristics between AERONET-Ocean Color and VIIRS sensor and impact assessment on the retrieval of ocean reflectance spectra

Eder Herrera, Yaron Klein and Alex Gilerson
The City College of New York, NOAA-CREST Optical Remote Sensing Laboratory

INTRODUCTION

Selection of an accurate aerosol model for atmospheric correction becomes more difficult in coastal waters due to high ocean particle backscattering and variability of aerosol composition. To assess the aerosol model selection algorithms, in-situ data from the AERONET-Ocean Color (OC) radiometers, at LISCO, and WaveCIS stations, are compared to data from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor. Phase functions from AERONET and aerosol models are compared and their impact on the retrieved AOD and Rrs are evaluated.



MOTIVATION

Satellite retrievals over coastal waters are hampered by the scene's optical complexity. Thus, selection of an accurate aerosol model is a key challenge of the atmospheric correction process in ocean remote sensing.

In-situ AERONET-OC measurements provide reliable estimates of water leaving radiance, from which Remote sensing reflectance (Rrs) can be derived, and therefore constitute a precious resource for validation.

METHODS

- Total TOA reflectance, above ocean can be described as

$$\rho_t(\lambda) = \rho_{\text{Rayleigh}}(\lambda) + \rho_{\text{aerosol}}(\lambda) + t\rho_{water}(\lambda)$$

where the different ρ values describe the reflectance resulting from their subscript origin (Rayleigh and aerosol scattering, and the water itself), the most difficult part to obtain is $\boldsymbol{\rho_{\text{aerosol}}}$:

$$\boldsymbol{\rho_{\text{aerosol}}(\lambda) = \frac{\omega_a(\lambda)\tau_a(\lambda)p_a(\theta,\theta_0,\lambda)}{4cos\theta cos\theta_0}}$$

where $\boldsymbol{\omega_a}, \boldsymbol{\tau_a}, \boldsymbol{p_a}$ are the aerosol single scattering albedo, the aerosol optical thickness (AOD), and the aerosol scattering phase function (PF) respectively.

The angles θ_0, and θ are the zenith angles from the point of examination to the sun and sensor, respectively.

- In order to examine the effects of different aerosol models on Rrs, L2 files generation was conducted using aerosol models that were chosen by a different criteria than NASA's model selection process.
- VIIRS satellite observations during the years 2014-2016 over the AERONET LISCO and WaveCIS Sites were compared.
- The VIIRS measurements were compared under two cases: (1) Standard NASA Processing and (2) Modified Processing with assigned aerosol models.
- Aerosol model assignment was conducted based on

$$\text{Phase Function (PF) error} = \min\left(\left|\frac{\text{PF}(870)^{\text{AERONET}} - \text{PF}(870,\alpha)^{\text{model i}}}{\text{PF}(870,\alpha)^{\text{model i}}}\right|\right)$$

- Satellite measurements were considered if taken within a two hour difference from the AEARONET measurement, and do not contain the flags: Land, high and moderate sun glint, high sensor viewing or solar zenith angle, straylight (suspended for LISCO for its close proximity to land), cloud or ice, and bad navigation.
- The procedure was repeated on a 3x3 gridbox centered at the site's pixel, retaining the averaged Rrs if at least 50% of pixels pass the flags. Moreover, pixels characterized by negative Rrs at any of the wavelengths are excluded from averaging at that wavelength.

RESULTS

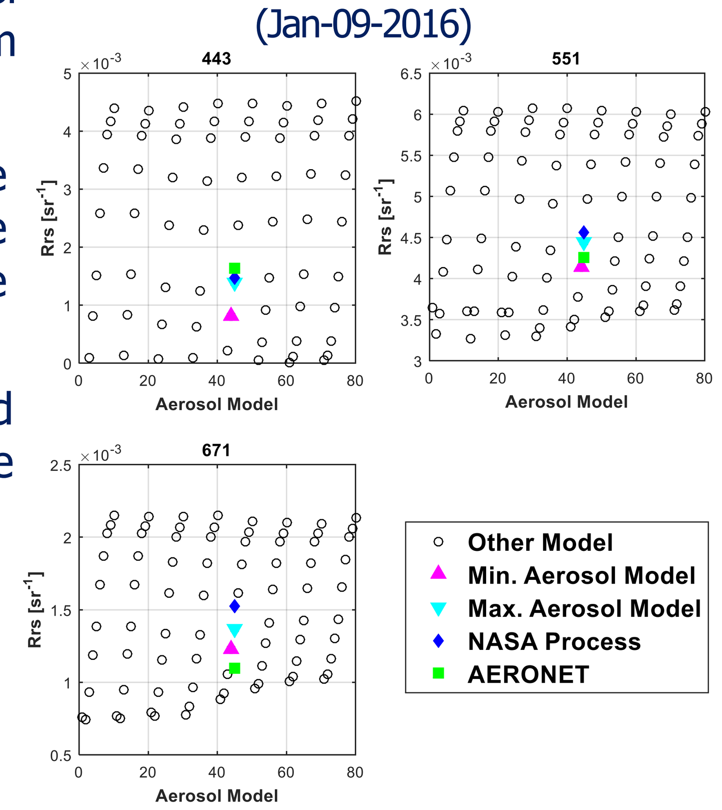
Each L2 file has two aerosol model boundaries (maximum and minimum.

The Aerosol models are determined by relative humidity (RH) and particle size fraction.

The accuracy of the selected aerosol model vary with the wavelength.

Rrs values are affected by changes on the size fraction more than on the RH.

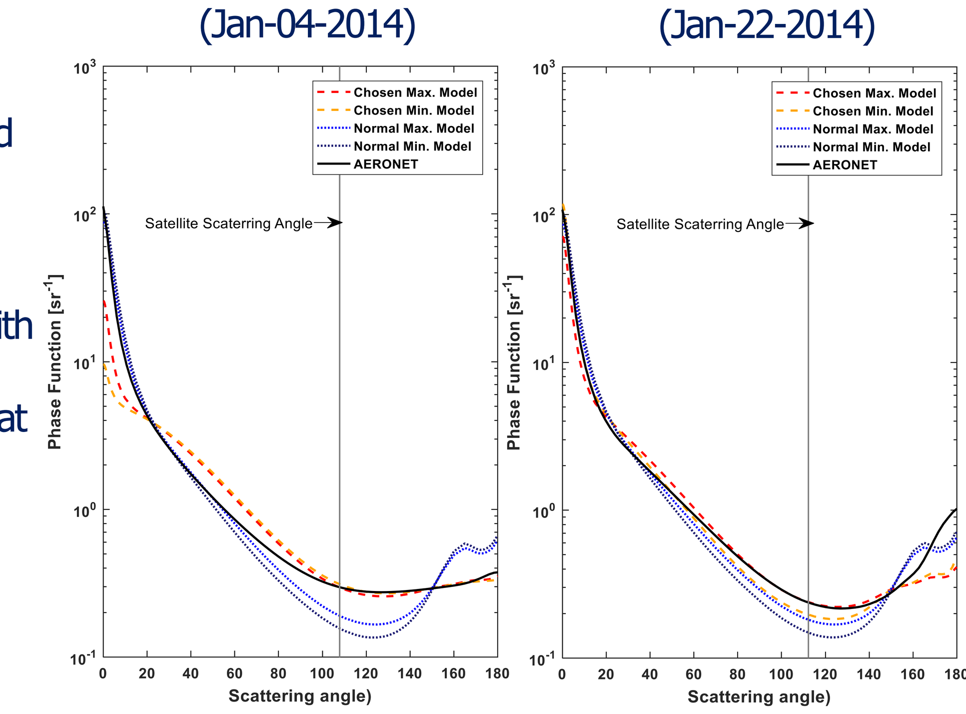
WaveCIS Site SCI 6 (Jan-09-2016)



The choice of model was based on the absolute error of the models' phase function value with respect to the AERONET data, at the satellite's scattering angle (vertical line).

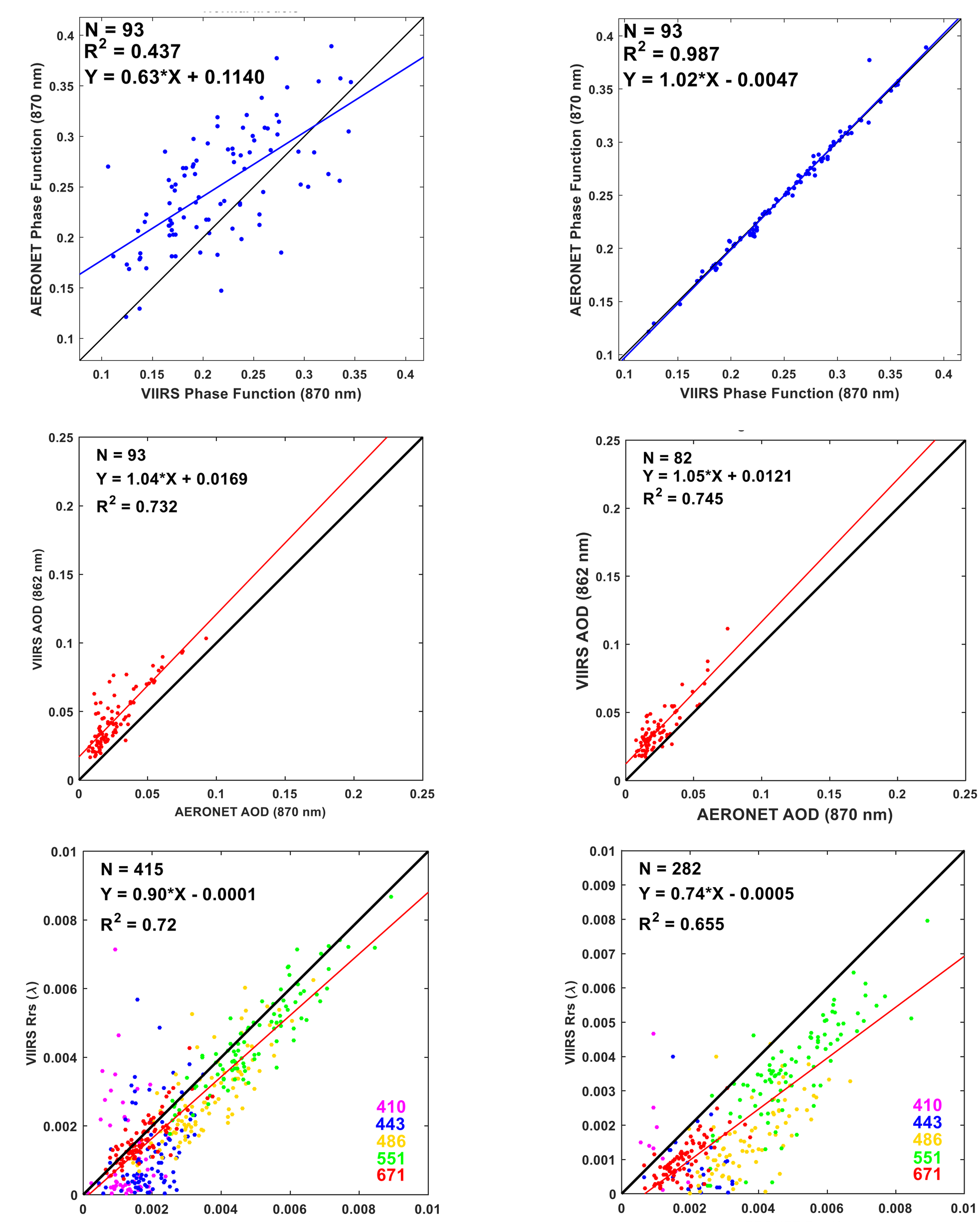
Phase Function curve (870 nm)

LISCO (Jan-04-2014) WaveCIS (Jan-22-2014)



LISCO — NASA / Selected Aerosol Models

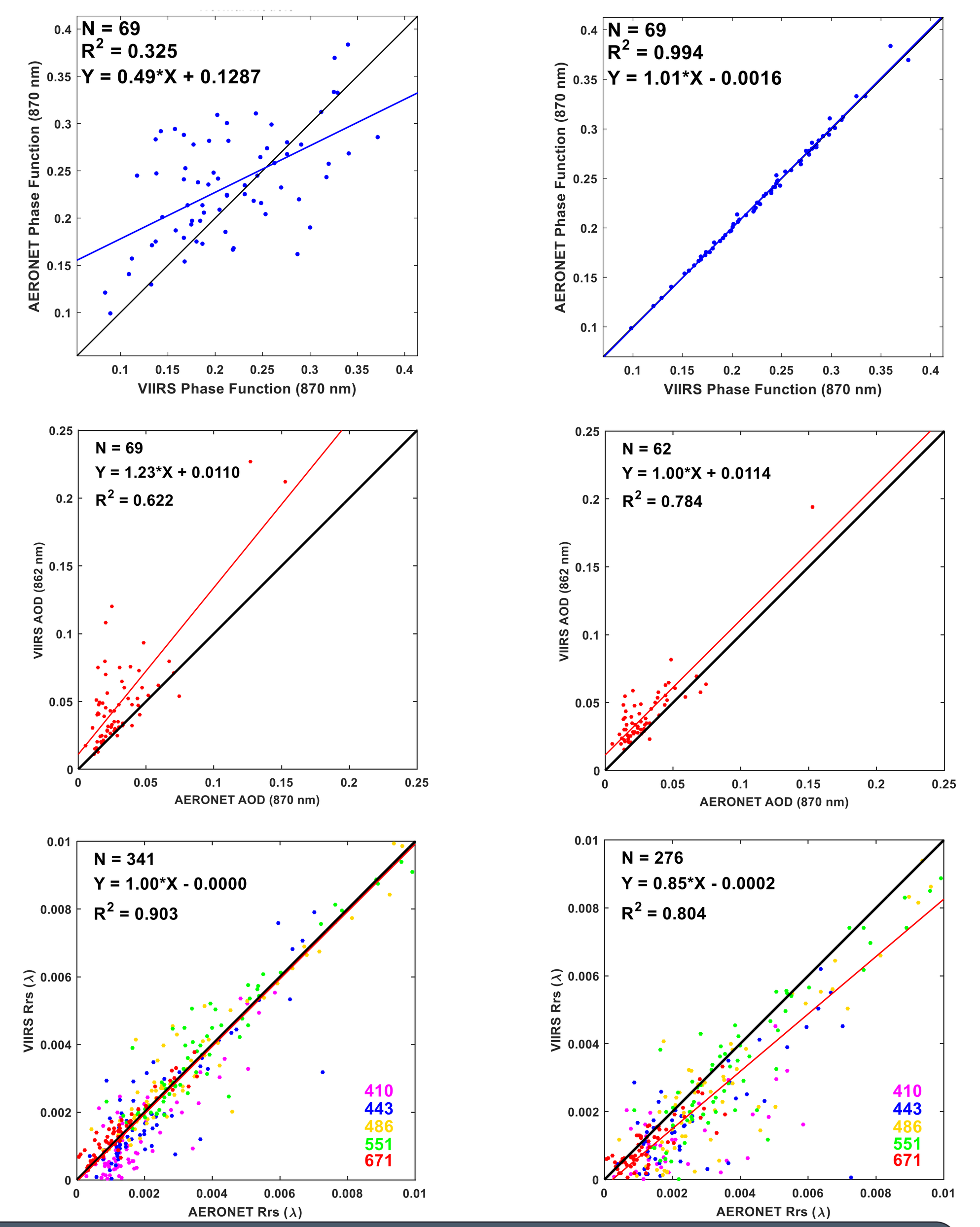
WaveCIS — NASA / Selected Aerosol Models



Since the criteria is PF error, the selected aerosol model present an almost perfect match to AERONET phase function values at band 870 nm.

Surprisingly, the modified processing show a better match of the aerosol optical depth at band 870 nm, more so in WaveCIS.

Nevertheless, for the modified processing, both station have less accurate Rrs values, than the normal NASA process.



CONCLUSIONS

- Although the aerosol model is determined by both particle size fraction and relative humidity, particle size fraction is of higher influence when retrieving Rrs values
- Selection of aerosol models based on Phase Function error alone give us lower correlation of Rrs values by wavelength but higher correlation on aerosol optical depth at 870 nm (AOD 870).
- These findings suggest further research on the parameters that influence selection of the aerosol models such as AOD, $\boldsymbol{\omega_a}$.

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